Journal of Forestry Research (2012) 23(4): 599−607
DOI 10.1007/s11676-012-0300-2

ORIGINAL PAPER

Plant community and ecological analysis of woodland vegetation in Metema Area, Amhara National Regional State, Northwestern Ethiopia

Haile Adamu Wale • Tamrat Bekele • Gemedo Dalle

Received: 2011-06-01 Accepted: 2011-10-26

Abstract: We studied woodland vegetation in broad-leaved deciduous woodlands of Metema in northwestern Amhara regional state, Ethiopia to determine plant community types and species distribution patterns and their relationships with environmental variables, including altitude, pH, cation exchange capacity, electrical conductivity (EC), and moisture. We used a selective approach with a systematic sampling design. A total of 74 quadrats, each 25m × 25m at intervals of 150−200 m were sampled along the established transect lines. For herbaceous vegetation and soil data collection, five subquadrats each 1m × 1m were established at the four corners and the center of each quadrat. Three community types were identified using TWINSPAN analysis. All three community types showed high diversity (Shannon-Weiner index), the highest in community type II at 3.55. The highest similarity coefficient was 0.49 (49%) between community types II and III, reflecting 0.51 (51%) dissimilarity in their species richness. The canonical correspondence ordination diagram revealed that the distribution pattern of community type I was explained by moisture while that of community types III and II was explained by EC and altitude and moisture, respectively. Altitude was the most statistically significant environmental variable, followed by moisture and EC in determining the total variation in species composition and distribution patterns while pH and cation exchange capacity were non significant. In conclusion, we recommend that any intervention should take into account these three discrete community types and their environmental settings to make the intervention more successful.

Keywords: equitability; diversity; dryland; environmental variables; ordination; metema woodland; plant community types; similarity

Foundition project: The study was supported by Special Fund for Public Welfare Technology Research of Agricultural Industry (200903014).
The online version is available at http:// www.springerlink.com

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Responsible editor: Zhu Hong

Introduction

Four broad vegetation types occur in the arid and semiarid regions of Ethiopia (Friis 1992), including broad-leaved deciduous woodland, small-leaved deciduous woodland, lowland dry forest, and lowland semi-desert and desert. Human pressure is considered to be the major cause of desertification in the dryland parts of the world. Furthermore, the effects of global climate change, which prevails in the dryland regions, are further intensifying problems in dry regions.

The Metema area is a dryland part of Ethiopia located in northwestern Amhara Regional State. Like other dryland parts of the country, land degradation is rife in Metema because of over exploitation of the woodlands and farming of the fragile lands. Encroachment of agriculture onto natural woodlands, burning, and overgrazing resulted in the clearing of woodlands (Sisay 2006). Ecological degradation of the area has been reported by Abeje et al. 2005; Mulugeta et al. 2007; Sisay 2006; Tatek 2008. Most of these studies focused on woody species with a special emphasis on the production, population structure, soil seed bank, and alternative land use options for frankincense producing species. Thus we lack of baseline information on the general plant diversity, plant community, and other ecological perspectives.

Our research provides information on plant community types and their distribution patterns. We provide a species list for the study area, quantify the diversity of plant species, and describe plant communities to characterize the patterns of plant species distributions and their relationships with selected environmental variables.

Materials and methods

Study area

The study was carried out at Metema district, one of 18 districts in the North Gondar Zone of the Amhara National Regional State

of Ethiopia. The study area is located at 36°17' E (204893 UTM) and 12°39 N' (139996 UTM) in North Gondar about 975 km northwest of Addis Ababa. It lies within an altitudinal range of 550 to 1608 m a.s.l. The total area of the district is about 440×10^3 ha (Fig. 1).

The National Meteorological Agency of Ethiopia (2009) reports the annual rainfall at Metema as 514.4−1128 mm with mean annual rainfall of 924.2 mm. The mean monthly minimum and maximum temperatures at Metema district are 19.31°C and 35.65°C, respectively. Mean annual temperature is 32.98°C.

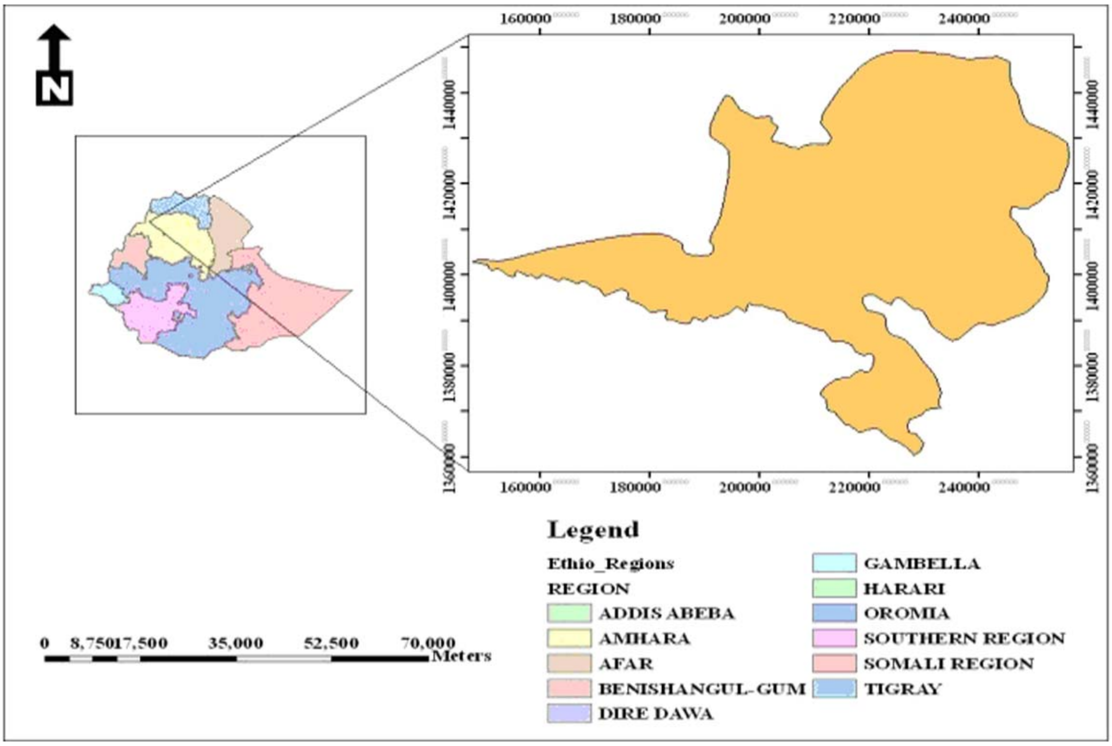

Fig. 1 Map of the study area

Data collection

We systematically sampled quadrats of 25m × 25m (625 m^2) at intervals of 150−200 m, following the homogeneity of the vegetation. For tree and shrubs, we sampled the main quadrats. For herbaceous species and soils, we sampled five sub-quadrats, covering 1m ×1 m within each main quadrat, four sub-quadrats at each corner and one at the center (Fig. 2).

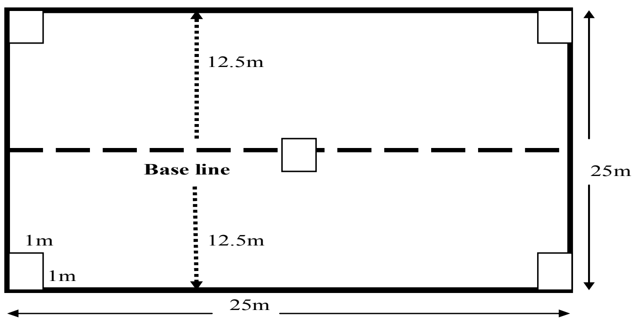

Fig. 2 Sampling design

All plant species in all quadrats were recorded. Ground cover of all vascular plants in each quadrat was estimated and rated according to the modified Braun Blanquet approach (Van der Maarel 1979). In all quadrats, additional trees and shrubs outside each main quadrat but within 10−15 m of the quadrat boundary were recorded and noted as present. Additional field layer species encountered outside the subquadrats were also recorded as present. Collected plant specimens were identified at the National Herbarium of Addis Ababa University. Environmental variables including altitude and geo-reference points (northing and easting) were recorded and soil samples were collected from each quadrat. Location and altitude at each quadrat were measured using Geographic Positioning System (GPS). Soil samples from each of the five sub-quadrats were taken at a depth of 0−15 cm. The soil samples from the five sub-quadrats were pooled (up to the weight of 0.7−1 kg) for each main quadrat and analyzed for pH, electrical conductivity (EC), cation exchange capacity (CEC) and moisture.

Vegetation data analysis

Species richness is a biologically appropriate measure of alpha diversity and is usually expressed as number of species per sample unit (Whittaker 1972). The number of species (species richness) was determined by summing up the number of species identified. We calculated Shannon-Weiner diversity indices to

quantify total Metema floristic diversity and evenness. For analysis, the cover-abundance value of each encountered species was used.

Multivariate analysis

Classification Analysis

The vegetation data matrix was analyzed and classified using the computer program TWINSPAN (Two-way Indicator SPecies Analysis) for Windows version 2.3 (Hill and Šmilauer 2005). The TWINSPAN classifications were used together to obtain an ordered two-way table that expressed the species' synecological relations (Hill and Šmilauer 2005).

To analyze with this program, the percentage canopy cover-abundance value of all vascular plant species that had been rated based on the 1−9 scale of Braun-Blanquet was further converted into Canoco condensed format using WCanoImp Help File (Šmilauer 2002a), which is the subprogram in the Canoco for Windows version 4.5 (Braak and Šmilauer 2002). After identifying the community types from the ordered two-way tables of WinTWINS output, the distinguished community types were further refined in a synoptic table where each column represents a community type. These synoptic values were calculated as the product of species frequency and average cover-abundance values following Tamrat (1993). Finally, the types were named after the three dominant and/or characteristic species.

Diversity and Equitability

We used Shannon Weiner diversity and evenness indices to compare the diversity and equitability between the derived community types. Diversity curves were plotted to compare species richness and species diversity patterns between the derived community types, following Gotelli and Colwell (2001). Diversity curve analyses were carried out using PAST version 1.62 (Hammer et al. 2001).

Similarity index

We used the Sorensen similarity coefficient to compare similarity of community types in terms of species richness. According to Dent and Wright 2009; Kent and Coker 1992, this index is widely used because it gives more weight to the species that are common to the samples rather than to those that only occur in either sample. Accordingly, Sorensen coefficient of similarity (S_s) was calculated as follows:

$$S_s = \frac{2A}{2A+B+C} \tag{1}$$

where, S_s is Sorensen similarity coefficient, A is number of species present in both samples, B is number of species present only in sample 1, and C is number of species present only in sample 2.

Ordination Analysis

Canonical Correspondence Analysis (CCA) was employed to do ordination. CCA reveals the linear combinations of environmental variables, explaining most of the variation in the species scores along the ordination axes (Kent and Coker 1992; Tamrat 1993). The biplot, species/environment CCA was performed with the procedures in the computer program package of CANOCO version 4.5 (Braak and Šmilauer 2002). All the species cover-abundance values (rated and condensed) and environmental data were used in this analysis. The resulting ordination diagram was further analyzed to describe the distribution pattern of the derived community types using CanoDraw for Windows version 4.0 (Šmilauer 2002b), the subprogram in Canoco for Windows version 4.5.

Statistical significance of the environmental variables in explaining the total variation in species distribution was tested using the Monte-Carlo permutation test, following a forward selection of CANOCO (Lepš and Šmilauer 2003; Gemedo 2004). Statistical analysis was also carried out to determine the significance of correlation between environmental variables by calculating a matrix of Pearson's correlation coefficient. MINITAB statistical software in version 14.13 (MINITAB 2004) was used to analyze this correlation analysis.

Results

Floristic composition, plant diversity, and equitability analysis

A total of 87 vascular plant species from 36 families and 74 genera were identified from 74 quadrats at elevations of 728 to 932 m a.s.l. The five dominant families in the area were Fabaceae, representing 16 species (18.39%) of 13 genera, Poaceae, with 9 species (10.34%) of 8 genera, Combretaceae, with 7 species (8.05%) of 3 genera, Acanthaceae, with 5 species (5.75%) of 5 genera, and Asteraceae, with 5 species (5.75%) of 5 genera (Appendix 1). Overall species diversity was 3.67. The 87 species in the area were distributed evenly at 0.82 of evenness and dominance of 0.04.

Plant community assessment

We identified three discrete community types (Table 1) with details listed in the synoptic table (Table 2). The following names were assigned to the three community types based on their dominant and/or characteristic species.

Combretum collinum- Acacia sieberiana –Balanites aegyptiaca type

This community type was recorded at elevations of 744–830 m in 10 quadrats and included 49 species (Table 3 for quadrats). *Combretum collinum* was the dominant species in the tree layer. *Acacia sieberiana*, *Balanites aegyptiaca*, and *Tamarindus indica* were the characteristic species in the tree layer. *Strychnos innocua*, *Dichrostachys cinerea*, and *Ziziphus abyssinica* were dominant in the shrub or tree layer, while *Acacia polyacantha* was the characteristic species in this layer. *Indigofera longibarbata* was dominant in the field layer. Other species were *Hypoestes forskaolii* and *Hygrophilia schulli*.

Table 1. TWINSPAN output of Metema vegetation. I, II, and III represent community types

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 39 Mayt Sene ------1--- -------------------------------------------------- -------------- 000010
 44 Dios Prah ----1----- -------------------------------------------------- -------------- 000010
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 15 Acac Seya ---------- --------------------------------------3----------- -------------- 000111
 20 Ochn Leuc ---------- -------------3------------------------------------ -------------- 000111
 22 Grew Moll ---------- ---3----------------------------------3----------- -------------- 000111
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Table 2. Synoptic phytosociological table for the community types

Species	I	II	III
	10	50	14
Combretum collinum	**4.00**	1.58	0.36
Acacia sieberiana	**2.10**	0.00	0.00
Balanites aegyptiaca	**1.70**	0.00	0.00
Strychnos innocua	1.70	0.60	0.36
Dichrostachys cinerea	1.60	0.44	0.00
Ziziphus abyssinica	1.50	0.10	0.00
Acacia polyacantha	1.20	0.00	0.00
Indigofera longibarbata	0.80	0.50	0.71
Tamarindus indica	0.60	0.00	0.00
Albizia melanoxylon	0.50	0.00	0.36
Hypoestes forskaolii	0.40	0.20	0.14
Hygrophilia schulli	0.30	0.28	0.14
Boswellia papyrifera	0.70	**4.16**	2.79
Lannea fruticosa	3.10	**4.14**	1.50
Pterocarpus lucens	1.60	**3.90**	0.71
Cobretum adenogonium	0.80	1.34	0.36
Terminalia laxiflora	0.00	1.08	0.00
Albizia lophantha	0.00	0.86	0.00
Ximenia Americana	0.50	0.84	0.00
Monechma cilliatum	0.50	0.64	0.36
Combretum molle	0.40	0.62	0.00
Convolvulus Kilimandschari	0.00	0.46	0.00
Solanum anguivi	0.00	0.24	0.00
Allophylus rubiflorus	0.00	0.22	0.00
Grewia bicolor	0.20	0.22	0.21
Diospyros abyssinica	0.00	0.20	0.00
Ipomoea tenuirostris	0.00	0.16	0.00
Sterculea setigera	2.40	2.20	**6.07**
Anogeissus leiocarrpa	4.80	2.18	**5.29**
Dalbergia melanoxylon	0.00	0.10	**2.14**
Boswellia pirottae	0.70	0.24	1.36
Pennisetum pedicellatum	0.90	1.22	1.36
Panicum monticola	0.40	0.10	0.50
Bidens pilosa	0.00	0.22	0.43
Hibiscus cannabinus	0.00	0.22	0.29
Zinnia peruveana	0.00	0.24	0.29

Notes: Values are the product of average cover-abundance and frequency in the type. Species with at least one value ≥ 0.15 are included. Values in bold refer to characteristic species used to name each type.

Boswellia papyrifera-Lannea fruticosa- Pterocarpus lucens type
This community type was recorded at 728–792 m a.s.l in 50 quadrats with 74 species (Table 3 for quadrats). *Boswellia papyrifera*, *Lannea fruticosa*, and *Pterocarpus lucens* were dominant in the tree layer. Other dominant species in the tree layer were *Cobretum adenogonium*, *Combretum molle*, and *Grewia bicolor*. *Terminalia laxiflora*, *Albizia lophantha*, and *Diospyros abyssinica* were the characteristic species in the tree layer. *Ximenia americana* was dominant in the shrub or tree layer. *Monechma cilliatum* was dominant in the field layer. Other species in the field layer had *Solanum anguivi*, *Allophylus rubiflorus*, and *Ipomoea tenuirostris*.

Sterculea setigera-Anogeissus leiocarrpa-Dalbergia melanoxylon type
This community type was recorded at 766–932 m a.s.l in 14 quadrats with 44 species (Table 3 for quadrats). *Sterculea setigera*, *Lannea fruticosa*, *Dalbergia melanoxylon*, and *Boswellia pirottae* were dominant in the tree layer. *Pennisetum pedicellatum* was dominant in the field layer. Other dominant species in the field layer were *Panicum monticola*, *Bidens pilosa*, *Hibiscus cannabinus*, and *Zinnia peruveana.*

Table 3. Community types and quadrats

Community	Quadrats	Altitude(m)
I	57,1,56,63,68,62,72,71,74,69	744–830
II	60,59,61,41,51,52,53,55,9,12,14,19,31,33,39,48,58,64,7,25,26,27,29,30,35,44,10,28,34,40,42,43,45,46,47,50,54,32,67,36,37,38,21,65,66,22,49,70,23,24	728–932
III	73,2,4,13,3,15,6,5,20,11,8,18,16,17	776–792

Similarity, diversity and evenness of community types
All three community types showed generally high species diversity (Table 4). Evenness was moderate and dominance was low in all types. According to the diversity curves (Fig. 3) and Sorensen similarity coefficient analyses, the three community types were different. Owing to their differences in numbers of quadrats, species richness, and diversity distribution patterns, the three communities were discrete. The highest similarity coefficient was 0.49 (49%) between community types II and III, reflecting 0.51 (51%) dissimilarity in their species composition. The dissimilarity between types I and II, and between types I and III was 0.60 (60%), and 0.65(65%), respectively.

Table 4. Diversity and evenness of three community types

Diversity indices	I	II	III
Shannon	3.43	3.55	3.08
Shannon Evenness	0.63	0.48	0.51
Dominance	0.05	0.05	0.08
Species Richness	49	74	44

Ordination

Canonical correspondence analysis of quadrats (Table 5) showed the relationship between total vegetation data and environmental variables. Axis 2 reflects EC, pH, moisture, and CEC while axis 1 reveals a gradient of altitude (Alt). The canonical correspondence analysis coefficients revealed that EC and moisture were most significant in determining variation in species composition, followed by pH and CEC in axis 2. In total, the first two axes accounted for 89.6% of variance in the species/environment data implying the constraint analysis of the first two axes generally explain floristic and environmental data. Altitude was the most statistically significant environmental variable in determining

general species distribution and association (Table 5), followed by moisture and EC at $p < 0.05$. However, pH and CEC were non-significant in explaining the total species distribution patterns in the woodland.

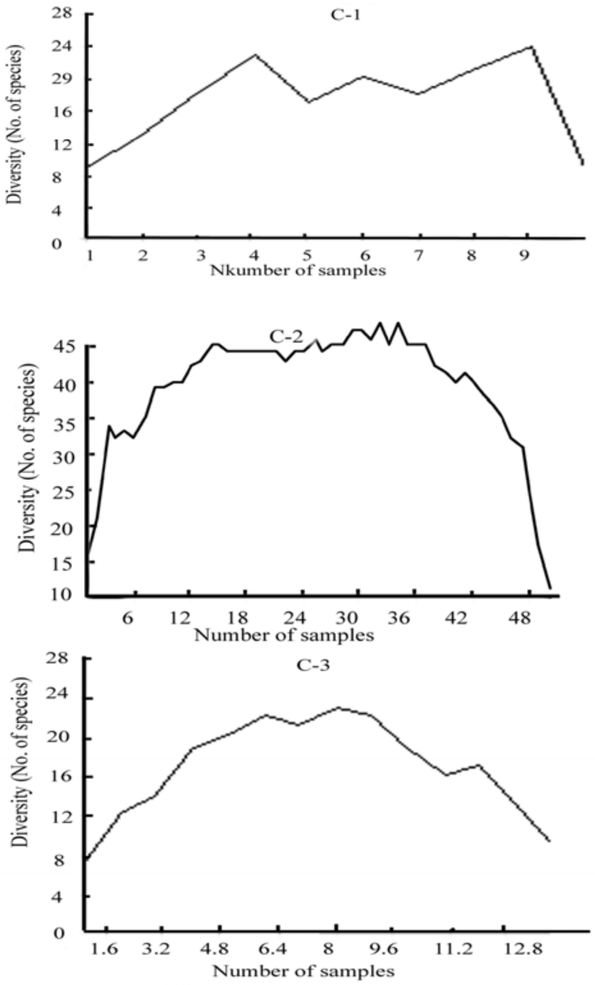

Fig. 3 Diversity curves of three community types: (community1 (C-1), community 2 (C-2), and community 3 (C-3)

Distribution patterns of the three community types according to environmental variables (Fig. 4) showed the three types emerging to the right and left of the diagram. However, due to the fact that community types I and II overlapped, further ordination analysis was performed only for community types II and III to reveal the clear separation (Fig. 5). From the ordination results (Fig. 4 and 5), it can be generally concluded that species of type I (*Combretum collinum–Acacia sieberiana –Balanites aegyptiaca*) occurred along a moisture gradient and their association was explained by soil moisture. Species of type III (*Sterculea setigera–Anogeissus leiocarrpa–Dalbergia melanoxylon*) occurred along an EC gradient and their association and distribution were explained by EC. Species of community type II, *Boswellia papyrifera–Lannea fruticosa–Pterocarpus lucens*, occurred along altitude and moisture gradients, and their distributions were explained by moisture and altitude.

Table 5. Correlations of species ordination axis with environmental variables, eigenvalues, and percentage variances explained from canonical correspondence analysis of the first two axes (axis 1 and axis 2).

Factors	Axis 1	Axis 2	Monte-Carlo Test(p<0.05)		
			Eigenvalues	F-ratio	p
Altitude	0.7905	0.2145	0.183	1.801	0.002
Moisture	-0.1444	-0.6196	0.133	1.295	0.034
Electrical Conductivity	-0.4787	0.5024	0.154	1.508	0.036
pH-H_2O	-0.3421	-0.1825	0.090	0.871	0.728
Cation Exchange Capacity	-0.1361	-0.0835	0.083	0.803	0.86
Eigenvalue	0.195	0.179	**Axis 1**	1.808	0.044
Species-environment correlations	0.863	0.821	**All Axes**	1.255	0.012
Variance of species environment relation (%)	30.7	58.9			

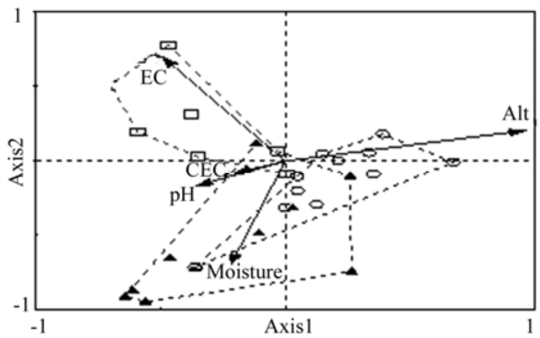

Fig. 4 Canonical correspondence ordination of the three communities. Each symbol represents the weighted average of one species. Each envelop encircling different symbols represents the three different communities: I (▲), II (○), and III (□).

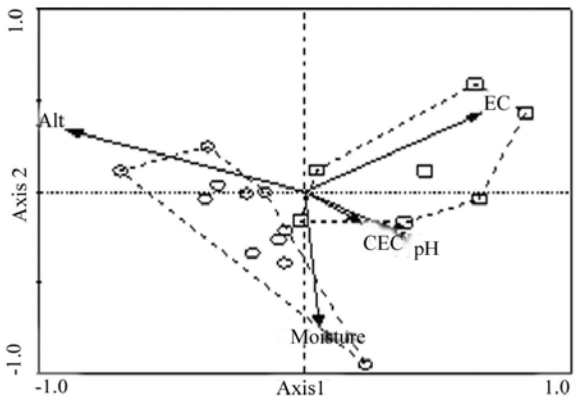

Fig. 5 Canonical correspondence ordination of the two communities. Each symbol represents the weighted average of one species**.** Each envelop encircling different symbols represents the two different communities: II (○) and III (□).

Correlation of Environmental Variables

CEC had strong positive correlation with EC, pH, and moisture at p<0.001. CEC had significant negative correlation with alti-

tude at $p < 0.05$. EC has significant correlation with pH positively at $p < 0.001$ and was negatively correlated with altitude at $p<0.01$. But its correlation with moisture was non-significant. pH had significant negative correlation with altitude and positive correlation with moisture at $p<0.001$. Finally, moisture had strong negative correlation with altitude ($p < 0.01$), (Table 6).

Table 6. Pearson's product moment correlation coefficients between environmental variables

CEC	-	EC	pH	Moisture	Altitude
EC	0.493***	-			
pH	0.881***	0.431***	-		
Moisture	0.664***	-0.024 ns	0.772***	-	
Altitude	-0.274*	-0.361 **	-0.428 ***	-0.319 **	-

Notes: *** is p <0.001; ** is p < 0.01;* is p < 0.05; ns is not significant.

Discussion

Community types

According to Clements (1916 as cited in Kent and Coker 1992), a plant community is a clearly recognizable and definable entity that repeats itself with regularity over a given region of the earth's surface. Based on this ecological concept, we tested whether the three community types of Metema woodland could be found among previously reported community types in other dryland parts of Ethiopia. We found that the community types of Metema woodland were different from community types reported from other dryland parts of the country. For instance, Gemedo et al. (2005) identified eight plant communities: *Acacia drepanolobium*–*Pennisetum meziamum*, *Bidens hildebrandtii*–*Chrysopogon aucheri*, *Chrysopogon aucheri*–*Commiphora africana*, *Cenchrus ciliaris*– *Chrysopogon aucheri*, *Acacia bussei*–*Pennisetum meziamum*, *Commiphora erythraea*–*Sansevieria ehrenbergi*, *Acacia mellifera*–*Setaria verticillata*, and *Heteropogon contortus*–*Hildebrandtia obcordata* from Borana lowland. Haileab et al. (2005), identified nine community types from the Rift Valley i.e., *Euphorbia tirucalli–Acacia tortilis–Euphorbia abyssinica*, *Ficus vasta–Ficus ingens–Ficus sycomorus*, *Steganotaenia araliacea–Maerua triphylla–Cussonia holstii*, *Euphorbia tirucalli–Solanum schimperianum–Acacia tortilis*, *Justicia schimperiana–Pavetta gardeniifolia–Cordia monoica*, *Olea europaea–Juniperus procera–Dodonaea angustifolia*, *Senna singueana–Pavetta gardeniifolia–Grewia velutina*, *Aeschynomene elaphroxylon–Sesbania sesban*, and *Pappea capensis–Rhus natalensis–Maytenus senegalensis.* This might suggest that Metema woodland is an isolated system with plant community types derived from interactions of local biotic and abiotic factors such as temperature, soils, rainfall, anthropogenic influences, fauna, topography, and geography.

However, community type II in our study showed similarities with one of the seven community types identified in the Gambella region by Tesfaye et al. (2001). This community type was *Combretum adenogonium-Anogeissus leiocarpa*. *Combretum adenogonium*, *Pterocarpus lucens, Terminalia laxiflorus*, and *Anogeissus leiocarpa* were the dominant species in the tree layer of the *Combretum adenogonium-Anogeissus leiocarpa* type. Similarly, in our study, *Combretum adenogonium*, *Pterocarpus lucens*, and *Terminalia laxiflorus* were the dominant species in the tree layer of community type II i.e., *Boswellia papyrifera-Lannea fruticosa- Pterocarpus lucens*.

The Gambella and Metema areas are located in relatively close proximity in adjoining geographical areas. This explains that they are more similar in their plant associations than Metema would be with either the Borana or Rift Valley regions, which are both distant from Metema. The complex interaction of environmental variables along spatial gradients forms a complex environmental gradient that characterizes the nature and distribution of communities along landscapes (Begon et al. 1996; Urban et al. 2000; Tuomisto et al. 2003).

Basically, Floristic composition of a given vegetation can be described in terms of its species richness, abundance, dominance, frequency, and Importance Value. Our total of 45 woody species at Metema (Appendix 1) shows that the woodland was floristically rich as compared to other dryland areas of the country. For instance, Mekuria et al. (1999) and Getachew (1999) studied woodlands of the Upper Rift Valley and found that there were only 6 woody species in established quadrats. Similarly, studies of the woodlands of northern Ethiopia reported that there were only 13 species (Kindeya 2003). Yabello lowlands of southern Ethiopia yielded only 23 species (Adefris 2006). We conclude that the Metema woodlands had diverse species composition, compared to other sites with more or less similar agro-ecology and vegetation formation in Ethiopia.

Environmental analysis

Plant community distributions along geographical gradients are manifestation of physical factors, such as elevation, soil heterogeneity, microclimate, biotic response to these physical factors, and historical disturbances (Urban et al. 2000). In this study, the canonical correspondence ordination analysis revealed that the distribution of community type I, II and III was determined by soil moisture, attitude and moisture, and EC, respectively. Elevation has been recognized as an important environmental factor that affects radiation, atmospheric pressure, moisture and temperature, all of which strongly influence the recruitment, growth, and development of plants and the distribution of vegetation types. We conclude that altitude was the most significant environmental variable, determining the general occurrence and distribution patterns of plant communities in Metema woodlands (Hedberg 1964; Friis 1992; Tamrat 1993; Lieberman et al. 1996; Lovett et al. 2001; Kumlachew 2002). Moisture and EC were the second and third most important environmental variables in determining the patterns of community occurrence and distribution.

Conclusions and recommendations

The ordination analysis revealed that community type I was most determined by moisture while type II was related to altitude and

moisture, and type III was related to EC. Of all the environmental factors studied, altitude was the most significant variable in explaining the total vegetation variations, followed by moisture and EC. CEC and pH were non-significant factors in explaining Metema woodland distribution or species composition. It is concluded that altitude is the most important environmental variable in determining the occurrence and distribution of plant communities. In conclusion, this study recommends that any future conservation management of the woodland should take into account these three different community types and their environmental settings. Finally, further research is needed to fill gaps of this research on the area of socio-economic and ethnobotanical perspectives.

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Appendix 1. List of plant species with their local name, botanical name, family, habit and author for Metema district (T/S is tree/shrub, Scs is scandent shrub and Sst is scandent shrub/tree)

Scientific name	Local name	Family	Habit	Scientific name	Local name	Family	habit
Acacia polyacantha Willd.	Gimarda	Fabaceae	Tree	*Grewia bicolor* Juss.	Sefa	Tiliaceae	Tree
Acacia seyal Del.	Yebirchiko Girar	Fabaceae	Tree	*Hibiscus cannabinus* L.	Yebereha Bamia	Malvaceae	Herb
Acacia sieberiana DC.	Nech Girar	Fabaceae	Tree	*Hygrophilia schulli* Almeida & Almeida	Amekella	Acanthaceae	Herb
Acanthospermum hispidum DC.	Akakima	Asteraceae	Herb	*Hyparrhenia arrhenobasis* (Hochst. ex Steud) Stapf	Wajel	Poaceae	Herb
Achyranthes aspera L.	Yeset Milas	Amaranthaceae	Herb	*Hypoestes forskaolii* (Vahl.) R. Br	Ras Kimir	Acanthaceae	Herb
Albizia lophantha (Willd.) Benth	Sete Gimarda	Fabaceae	Tree	*Indigofera longibarbata* Engl.	Yeahiya Abish	Fabaceae	Herb
Albizia melanoxylon (A. Rich) Walp.	Gebso	Fabaceae	Tree	*Ipomoea aquatica* Forssk	Wuha Ankur	Convolvulaceae	Herb
Allophylus rubiflorus (A. Rich) Engl	Nechllo	Sapindaceae	Herb	*Ipomoea tenuirostris* Chisy	Hareg	Convolvulaceae	Herb
Amaranthus hybridus L.	Adis Mete	Amaranthaceae	Herb	*Lannea fruticosa* (Hochst. ex A. Rich) Engl	Digunguna	Anacardiaceae	Tree
Anogeissus leiocarrpa (A. Rich) Guill. & Perr	Kirkira	Combretaceae	Tree	*Leucas martinicensis* (Jacq.) R. Br.	Awinda Mesay	Lamiaceae	Herb
Aristida adoensis Hochst	Gofer Sar	Poaceae	Herb	*Lonchocarpus laxiflorus* Guill. & Perr	Mebrat	Fabaceae	Tree
Aristida hordeacea Kunth	Jingira	Poaceae	Herb	*Maytenus senegalensis* Forssk	Dingay Seber	Celastraceae	Sst
Asparagus Africanus Lam.	Yeset Kest	Asparagaceae	Scs	*Maytenus undata* (Thunb.) Blakelock	Yebereha Atata	Celastraceae	S / T
Balanites aegyptiaca (L.) Del.	Lalo	Balanitaceae	Tree	*Melanthera abyssinica*	Mech	Asteraceae	Herb
Bidens pilosa L.	Gurjejit	Asteraceae	Herb	*Monechma cilliatum* (Jacq.) Milne.Redh	Yeset Guticha	Acanthaceae	Herb
Boerhavia erecta L.	Aremo	Nycataginaceae	Herb	*Ochna leucophloeos* Hochst. ex A. Rich	Yedebene Fes	Ochnaceae	Tree
Boscia mossambicensis Klosch	Temenhie	Capparidaceae	S / T	*Ocimum urticifolium* Roth.	Yedimet Zinka Kibie	Lamiaceae	Shrub
Boswellia papyrifera Hochst. ex A. Rich	Walya Meker	Burseraceae	Tree	*Oxytenanthera abyssinica* (A.Rich.) Mumro.	Shimel	Poaceae	Herb
Boswellia pirottae Choiv	Tikur Waliya Meker	Burseraceae	Tree	*Panicum monticola* Hook.f	Yekok Sar	Poaceae	Herb
Bridelia micrantha	Yenebir Tifir	Euphorbiaceae	S/ T	*Pennisetum pedicellatum* Trin	Zemen Sar	Poaceae	Herb
Calotropis procera L.	Tobia	Asclepiadaceae	Shrub	*Peristrophe paniculata (*Frossk) Brummit	Sire Bizu	Acanthaceae	Herb
Celosia argentea L.		Amaranthaceae	Herb	*Piliostigma thonningii* (Schumach.) Milne-Redth	Yekola Wanza	Fabaceae	Tree
Cissus populnea Guill. & Perr.	Azo Hareg	Vitaceae	climber	*Polygala persicariifolia* DC.	Shetora	Polygalaceae	Herb
Cobretum adenogonium Steud.ex A.Rich	Tikur Abalo	Combretaceae	Tree	*Pterocarpus lucens* Guill. & Perr	Charia	Fabaceae	Tree
Combretum collinum Fresen	Askir	Combretaceae	Tree	*Satanocrater ruspolii* (Lindau) Lindau	Kesse	Acanthaceae	Shrub
Combretum hartmannianum Schweinf	Teye	Combretaceae	Tree	*Senna occidentalis* (L.) Link	Yetezuari Medanit	Fabaceae	Herb
Combretum molle	Nech Abalo	Combretaceae	Tree	*Setaria pumila* (Pair.) Roem & Schultt	Buanfie Sar	Poaceae	Herb
Combretum sp Fresen	Kongora	Combretaceae	Tree	*Sida urens* L.	Abelbalit	Malvaceae	Herb
Commelina imberbis Hassk	Wef Ankur	Commelinaceae	Herb	*Smithia abyssinica* (A. Rich.) Verdc	Chifrigina	Fabaceae	Herb
Convolvulus Kilimandschari Engl. & Diels	Abo Hareg	Convolvulaceae	Herb	*Snowdenia polystachya* (Fresen.) Pilg.	Dimamo	Poaceae	Herb
Corchorus olitorius L.	Kudra	Tiliaceae	Herb	*Solanum anguivi* Lam.	Embuay	Solanaceae	Herb
Cyperus reduncus Böck	Gicha	Cyperaceae	Herb	*Sterculea setigera* Del.	Darlie	Sterculiaceae	Tree
Dalbergia melanoxylon Guill. & Perr	Zobi	Fabaceae	S / T	*Stereospermum kunthianum* Cham	Zana	Bignoniaceae	S / T
Desmodium dichotomum (Klein. Ex Willd.) Dc	Gid Zemede	Fabaceae	Herb	*Strychnos innocua* Del.	Kudkuda	Loganiaceae	S / T
Dichrostachys cinerea Wight & Am	Ader	Fabaceae	S/ T	*Tamarindus indica* L.	Kummer	Fabaceae	Tree
Dioscorea prahensilis Benth	Senssa	Dioscoreaceae	climber	*Terminalia laxiflora* Engl. & Diels	Wembella	Combretaceae	Tree
Diospyros abyssinica (Hiem) F. Wite	Serkin	Ebenaceae	Tree	*Triumfetta annua* L.	Chegogot	Tiliaceae	Herb
Eragrostis macilenta (A. Rich.) Steud	Yewef Sar	Poaceae	Herb	*Vigna ambacensi* Bak.	Yedur Barengua	Fabaceae	Herb
Ethulia gracilis Del.	Awunda	Asteraceae	Herb	*Ximenia Americana* L.	Enkoy	Olacaceae	S/ T
Euphorbia indica Lam.	Wetet Awchi Kitel	Euphorbiaceae	Herb	*Zehneria scabra* (Linn. F.) Sond.	Hareg Eressa	Cucurbitaceae	Herb
Ficus sycomorus L.	Bamba	Moraceae	Tree	*Zinnia peruveana* (L.) L.	Yebereha Abeba	Asteraceae	Herb
Ficus thonningii Blume.	Chibha	Moraceae	T/S	*Ziziphus abyssinica* Hochst. ex A. Rich	Foch	Rhamnaceae	S / T
Flueggea virosa Guill. & Perr.	Shasha	Euphorbiaceae	Tree	*Ziziphus spina-christi* (L.) Desf.	Geba	Rhamnaceae	S/T
Gardenia ternifolia Schumach & Thonn	Gambilo	Rubiaceae	S/T				